SEEDS FROM SURFACE SOILS IN A TROPICAL REGION OF VERACRUZ, MEXICO *

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IN THE DEVELOPMENT of studies on the secondary vegetation of lowland tropical regions of Mexico (Gómez-Pompa, 1971; Gómez-Pompa et al., 1964; Sarukhán, 1964; Sousa, 1964) it has been very clear that additional studies must be carried on if we want to learn more about the process of secondary succession. An important factor in the initiation of a secondary succession is the amount of seeds stored in the soil ("seed crop" or "floristic potential"). This area of ecological research has been developed to some extent in temperate regions (Champness, 1949; Champness & Morris, 1948; Milton, 1936, 1939, 1943, and 1948; Brenchley, 1918; Brenchley & Adam, 1915; Ovington, 1955; Olmsted & Curtis, 1946), but no records exist for tropical areas.

The importance of seeds in the soil for the development of secondary succession in the tropical regions may be even greater than in temperate ones, because the first colonizers will open the way for the other species (including the primary species) and this process of colonization and growth is very rapid in the humid tropics (Sarukhán, 1964; Budowski, 1965; Rico, 1972). Several hypotheses have been proposed to explain different aspects of succession but it is clear that what is needed is experimental work to obtain data as a basis for some of these hypotheses (Gómez-Pompa, 1967).

The opportunity for initiating such studies arose with the establishment, by the National University of Mexico, of the Tropical Biological Station at Los Tuxtlas, Veracruz, in an evergreen rain forest region.

The main objectives of the work reported in this paper were: to find a method for doing such investigation in a tropical region; to evaluate the difference between the seeds of a secondary vegetation soil and a primary one; to discover some of the relationships to various environmental factors in the two conditions, especially temperature and floristic composition of the surrounding vegetation. We were also looking for some clues to solve the problem of the trigger mechanisms in the germination of seeds of recently opened soils, which have a whole set of species different from the

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primary vegetation type (Oosting & Humphreys, 1940, 1947; Vázquez & Gómez-Pompa, 1971).

MATERIALS AND METHODS

Four areas were chosen for sampling purposes, two in secondary vegetation and two in primary vegetation. In each area a quadrat of 100 m² was selected for floristic, environmental, and soil studies. In each of the quadrats sixteen samples of soil were taken at random for seed germination purposes. In order to understand the changes through time these were repeated eight times during the year of the study. So, a total of eight time periods were surveyed. In each quadrat a floristic inventory was compiled to obtain an idea of the species growing in that soil site. Air (75 cm.) and soil (2 cm. deep, FIGURE 1) temperature and records of relative humidity

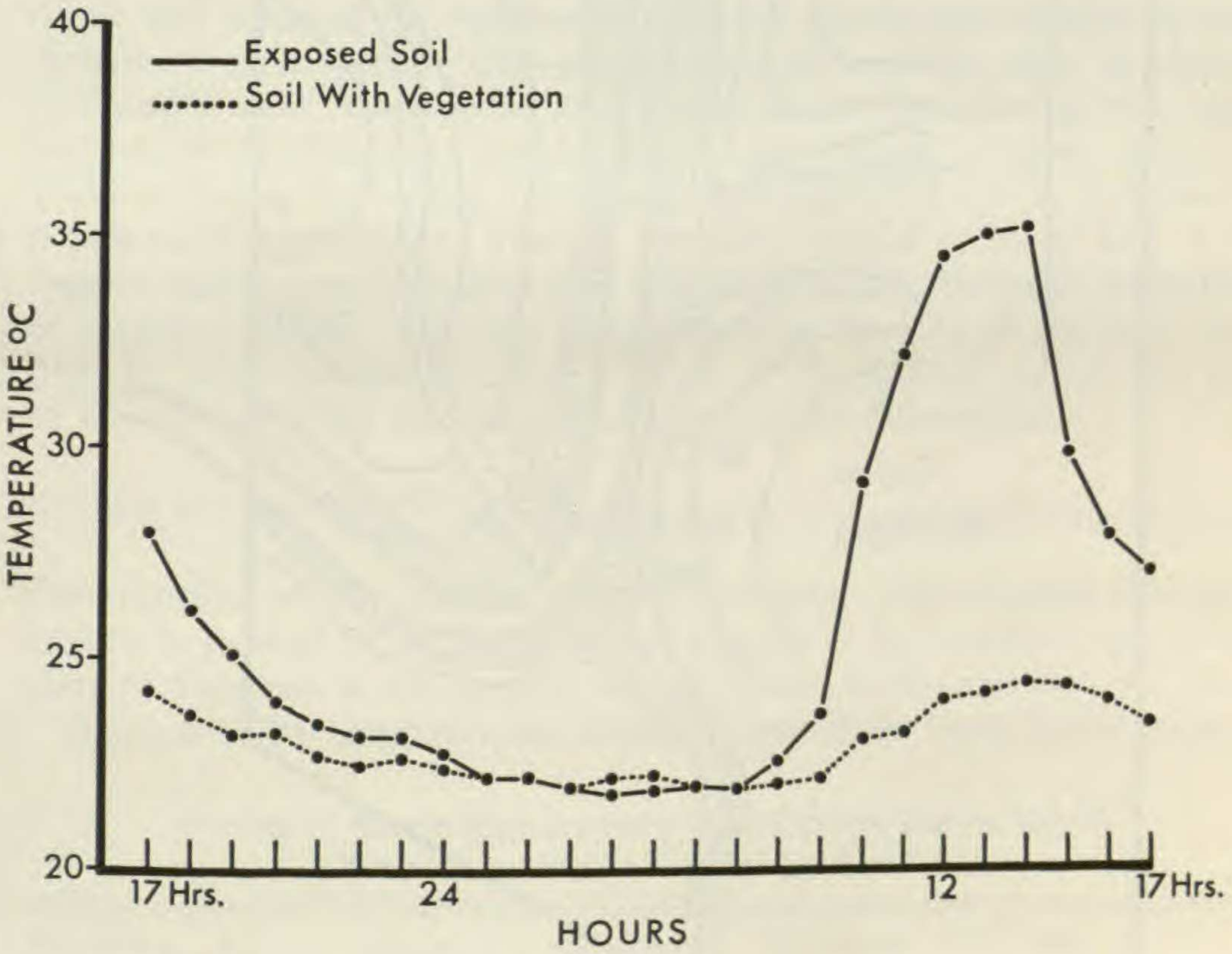


FIGURE 1. Soil temperature (24 hrs.).

were taken through the year in all the sampling sites, and precipitation data were available from the meteorological station in the Biological Station located a few hundred meters from the farthest point of the sampling sites (FIGURE 2).

The soil samples were taken with a specially constructed cylindrical metal sampler 477 cm³ in volume. Each soil sample was placed in a plastic bag and taken to a "germination house." There each sample was put on 400 gms. of vermiculite and placed in plastic plates in the "house."

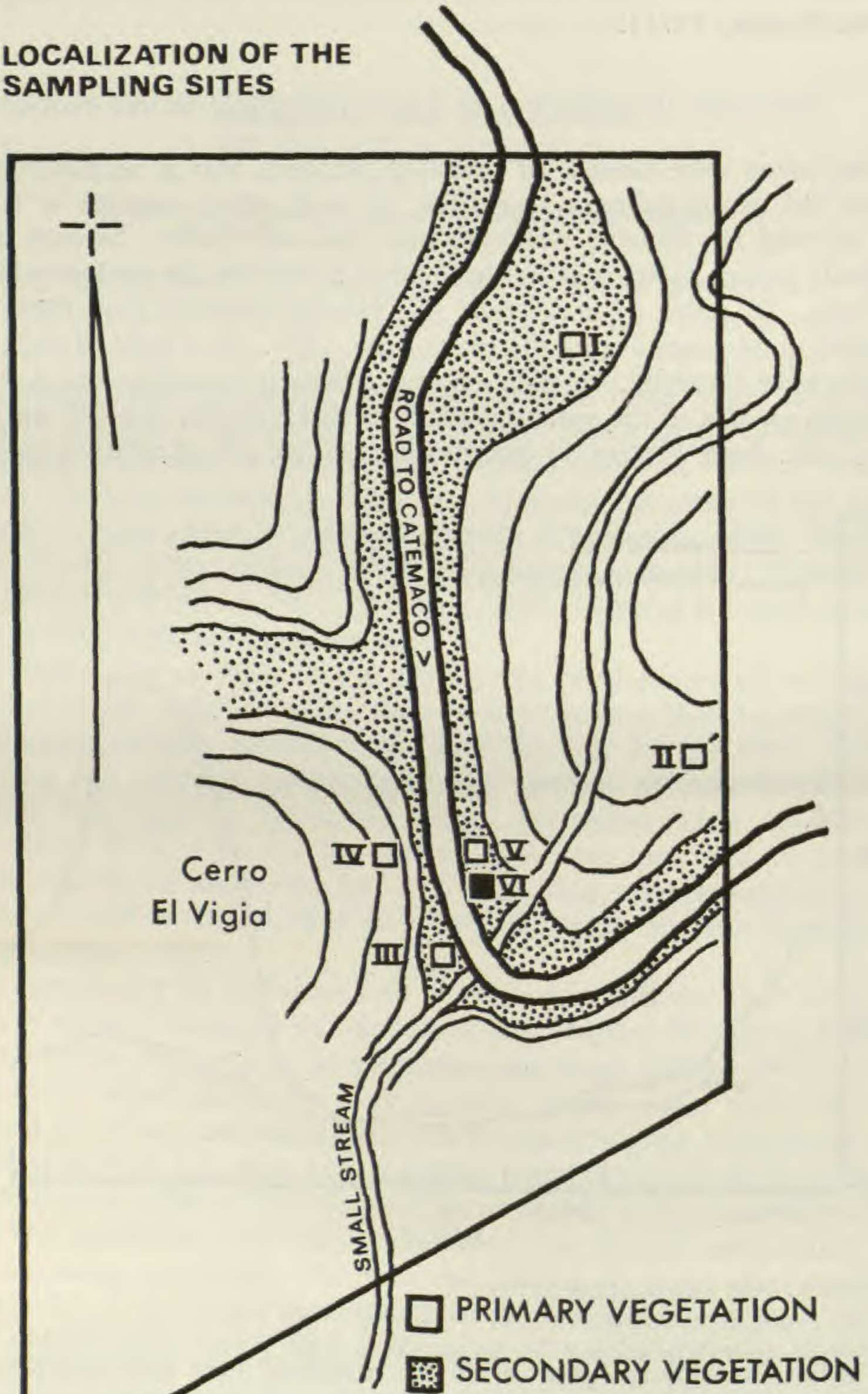


FIGURE 2. Localization of the sampling sites.

Germination was selected for evaluating the soil seed crop instead of a direct observation and count of the seeds in the soil (Barbour & Lange, 1967). The reasons for this are various but the most important one is the difficulty of identification of species by seeds (especially difficult for tropical species).

The only objective of the "germination house" was to protect the soil samples from seed contamination. It had a ceiling of thin plastic and walls of mosquito netting to permit free circulation of air. Temperature and humidity data were taken in this house also. The plates were circulated during the six weeks they remained in the house in order to have homogeneous conditions. They were watered daily with equal amounts of water (3.5 liters).

Four plates with only vermiculite were always in the house as controls for possible contamination. None were contaminated during the study.

After six weeks the plates were analyzed for the germinated plants. A count was made of the number of different species and number of individuals of each species. The species that we were not able to identify botanically were transplanted to a "nursery" for continued growth (age) and future identification. As the flora of the Station is known quite well (Gómez-Pompa & Nevling, 1971) the identification is not as unattainable a task as it may appear. Voucher specimens of the seedlings and of the "aged" plants were prepared and deposited in the National Herbarium of Mexico (MEXU). We want to acknowledge the help of Dr. L. I. Nevling, Jr., with the identification of some of the difficult species and that of Dr. R. McVaugh who identified some of the Compositae.

RESULTS

Description of the region of Los Tuxtlas. The Tropical Biological Station is located in the Sierra de los Tuxtlas in the southern part of the state of Veracruz in the parallel 18° 30′ N and in the meridian 95° W.

Because of its orography the region is one of the most humid areas in

FIGURE 3. **Meteorological records from Coyame Station and the Estacion de Biología Tropical Los Tuxtlas** [3]

METEOROLOGICAL STATION	MEAN TEMP. (° C)	EXTREME MAX. TEMP. (° C)	EXTREME MIN. TEMP. (° C)	RELATIVE HUMIDITY %	RAINFALL (mm.)
COYAME [1]	23.6	38.5 (May)	9.5 (January)	—	4419.8
ESTACIÓN DE BIOL. TROP. LOS TUXTLAS [2]	25.0	43.3 (June)	12.2 (February)	81.9	4012.0

[1] The record covers the period from 1921 to 1970.
[2] The record covers one year (1970).
[3] Taken from Soto (1972).

FIGURE 4. **Soil properties** *

DEPTH (cm.)	COLOR	TEXTURE	pH	% ORGANIC MATTER	NITRIC NITROGEN KG./HA	CALCIUM KG./HA	PHOSPHORUS KG./HA	POTASSIUM KG./HA
0–30	reddish brown	clay loam	6.25	4.45	27	3129	14.6	413
30–60	reddish brown	clay loam	6.20	1.37	14	1498	7.2	90
60–100	reddish brown	clay loam	5.80	1.71	14	1735	7.9	124

* Flores, 1971.

the Gulf Coast of Mexico and precipitation of more than 4 meters per year has been recorded (García, 1971) from nearby stations. Data available from the meteorological records of the station during the year of the study are recorded in FIGURE 3, but cannot be used for evaluation of climate because of lack of comparative data from preceding years. The closest station which can give a better idea of the climate is Coyame (FIGURE 3).

The vegetation of the region is composed of many types produced by variations in temperature, precipitation, and soil properties (Gómez-Pompa, 1972; Sousa, 1968), with a very rich floristic composition. Floristic differences may be seen within short distances. In adjacent areas floristic variations arise chiefly from secondary successional stages (Gómez-Pompa, 1971).

Description of the Station. The station is located on the NE slope of the Sierra of San Martín, very close to the coast, and is covered mainly by a High Evergreen Selva of an average of 30 meters in height, and a few secondary vegetation sites along the main road crossing the station property (FIGURE 2) on one side. The sampling was done on the lower slopes of a small hill (Cerro El Vigía) belonging to the station (as can be seen in FIGURE 2).

The soil in the station is a brown and yellow acid soil derived from volcanic ash. Some of its characteristics are indicated in FIGURE 4.

Description of the sampled sites. SITE 1. This area is covered with secondary vegetation about five years old. Before that time it was cultivated with corn for about one or two years, and before the corn, it was a primary High Evergreen Selva. This quadrat is located on a slope of about 15 to 30° inclination. There is a considerable quantity of volcanic alluvial rock over the surface (40%). The average height of the upper stratum is about 7 to 8 meters. The altitude is 108 meters above sea level. Some records of soil and air temperature during the study are shown in FIGURE 5, those of the humidity and dew point in FIGURE 6. The species collected are listed in FIGURE 7.

SITE 2. This area is covered with a High Evergreen Selva about 30 meters tall. The quadrat is located on a slope of about 15 to 30° inclination. It is also covered with a considerable proportion of volcanic rocks (30%). The altitude is 120 meters above sea level. Soil and air temperature are shown in FIGURE 5, records of humidity in FIGURE 6. The species collected are listed in FIGURE 7.

SITE 3. When the study started, the area was covered by secondary vegetation of two months' duration. The area was covered before that by secondary vegetation for a few months and earlier it was a Tall Evergreen Selva. The quadrat is located on a slope of about 20 to 40° inclination. Free of rocks. Observations of soil and air temperature and humidity are shown in FIGURES 5 and 6. The species collected are listed in FIGURE 7.

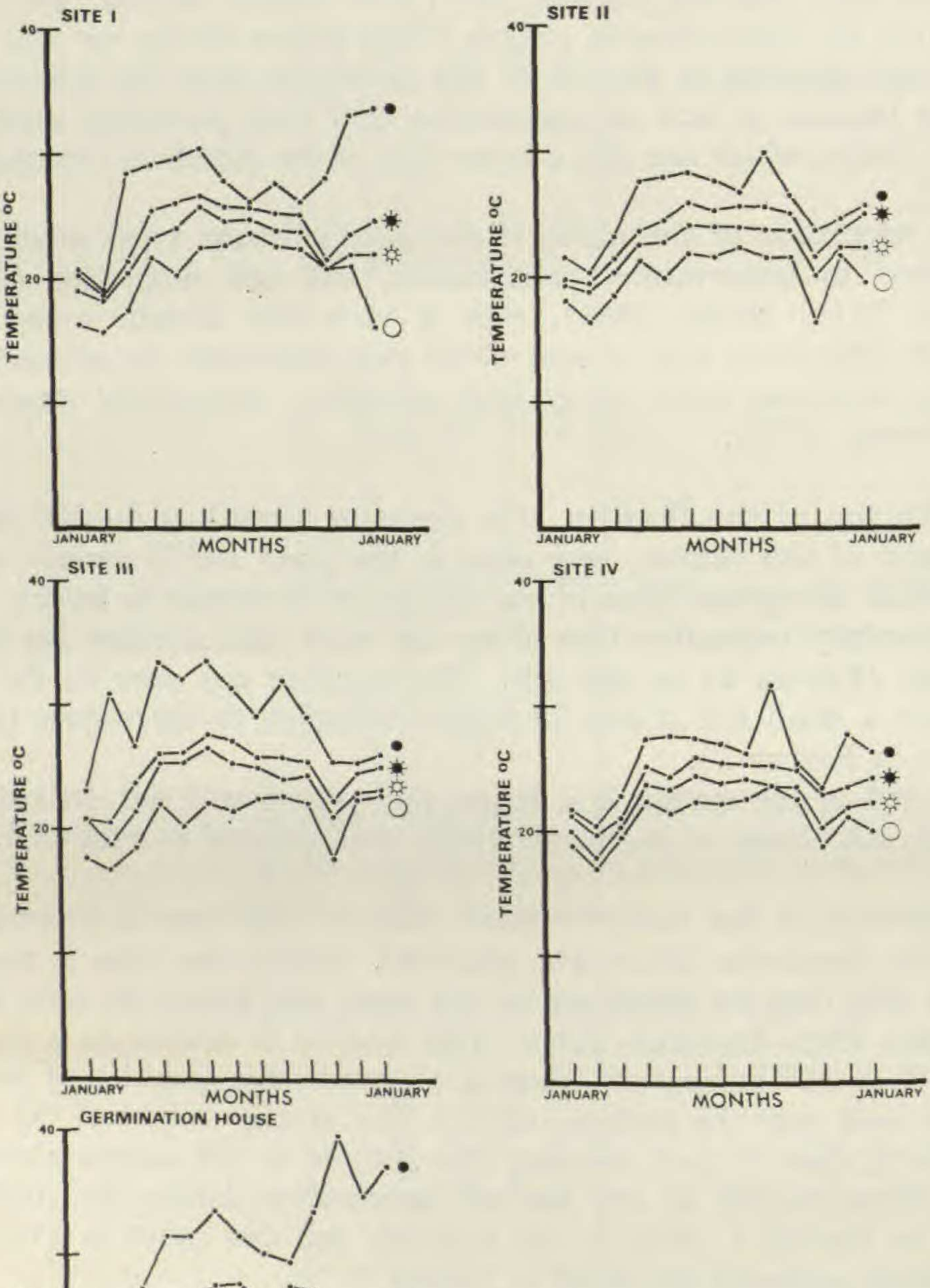


FIGURE 5. Air and Soil Temperature: ● max. temperature of air; ○ min. temperature of air; ✻ soil temperature after insolation (4:30 P.M.); ☼ soil temperature before insolation (7:30 A.M.).

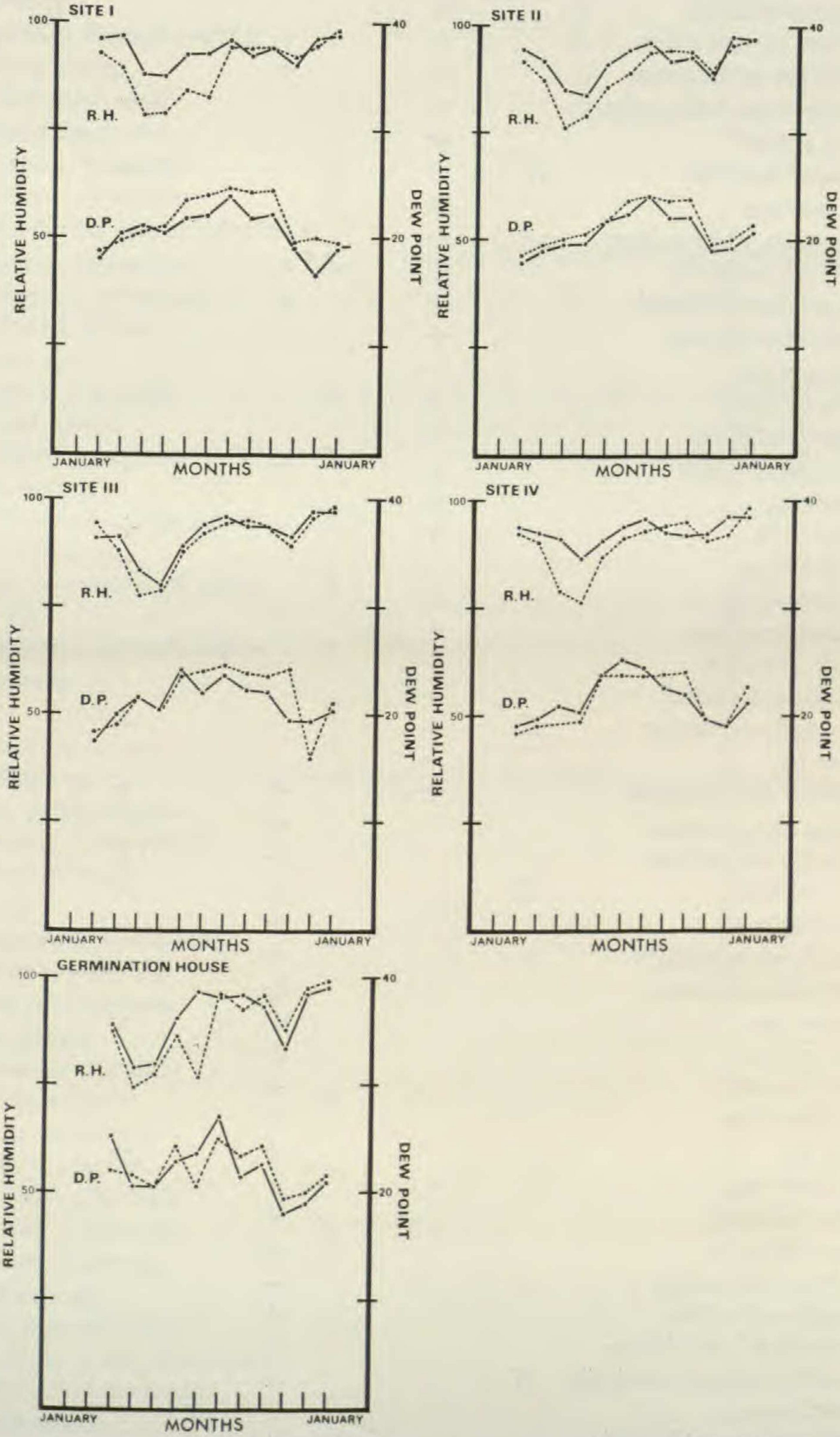


FIGURE 6. Air humidity: ——— 7:30 A.M.; . . . . . 4:30 P.M.

FIGURE 7. **Flora of the sampling sites**

SPECIES		SITE I	SITE II	SITE III	SITE IV
Aneilema geniculata		+			
Anthurium myosuroides		+	+		
Astrocaryum mexicanum		+	+		+
Cardiospermum halicacabum			+	+	+
Casearia arguta			+		
Cecropia obtusifolia	X		+	+	
Celtis iguanaea			+		
Citharexylum pterocladum			+	+	
Cupania macrophylla			+	+	+
Cymbopetalum baillonii			+	+	
Dieffenbachia seguine			+	+	
Eupatorium sp.			+		
Hamelia axillaris			+		
Litachne pauciflora			+		
Myriocarpa longipes			+	+	+
Passiflora sp.			+		
Piper auritum			+	+	
Piper hispidum			+	+	
Piper lapathifolium			+		
Piper martensianum			+		
Piper aff. *sanctum*			+		
Renealmia aromatica			+		
Robinsonella mirandae	X		+	+	
Solanum sp.			+		
Syngonium podophyllum			+	+	+	+
Aegiphila costaricensis				+		
Aphelandra aurantiaca				+	+	
Costus spicatus	X			+	+	+
Chamaedorea sp.				+		+
Chamaedorea tepejilote				+		
Dendropanax arboreus				+		
Diplazium sp.				+	+	+
Guarea bijuga				+		
Hiraea obovata				+		+
Ilex condensata				+		
Justicia sp.				+	+	
Lomariopsis sp.				+		
Lucuma durlandii				+		
Malmea depressa				+		
Monstera tuberculata				+		
Nectandra salicifolia				+		
Philodendron sanguineum				+		+
Pleuranthodendron mexicana	X			+		
Polypodium sp.				+		
Pseudolmedia oxyphyllaria				+		+
Reinhardtia gracilis				+		+

FIGURE 7 *Continued*

SPECIES	SITE I	SITE II	SITE III	SITE IV
Serjania sp.		+		
Syngonium donnell-smithii		+		
Tradescantia sp.		+		
Trichilia japurensis		+		
Acalypha deppeana			+	
Acalypha schiedeana	X		+	
Ageratum conyzoides	X		+	
Aspidosperma megalocarpon			+	
Brosimum alicastrum	X		+	
Calathea microcephala			+	
Campelia zanonia			+	
Cestrum sp.			+	
Cirsium mexicanum	X		+	
Clematis dioica			+	
Clibadium arboreum	X		+	
Elvira biflora			+	
Enterolobium cyclocarpum	X		+	
Eupatorium sp.			+	
Eupatorium macrophyllum	X		+	
Ficus sp.			+	+
Heliocarpus appendiculatus	X		+	
Inga spuria			+	+
Iresine celosia	X		+	
Jacobinia sp.	X		+	
Lygodium sp.			+	
Ocotea dendrodaphne			+	
Omphalea cardiophylla			+	
Paullinia pinnata			+	
Piper sp.			+	
Pothomorphe umbellata	X		+	
Rapanea myricoides			+	
Sapium lateriflorum			+	
Sicyos deppei			+	
Solanum amazonium			+	
Solanum nigrum	X		+	
Spigelia anthelmia			+	
Spondias mombin			+	
Taraxacum officinale			+	
Verbesina greenmani	X		+	
Vernonia deppeana	X		+	
Anthurium sp.				+
Croton macrodontus				+
Chamaedorea aff. *lindeniana*				+
Dieffenbachia oerstedii				+
Eugenia trikii				+
Oreopanax capitatum				+
Paullinia costaricensis				+

FIGURE 7 *Continued*

SPECIES	SITE I	SITE II	SITE III	SITE IV
Poulsenia armata				+
Salacia megistophylla				+
Thelypteris ghiesbreghtii				+
Trophis mexicana				+
Trophis racemosa				+

SYMBOLS: X Species of which seeds were found in the soil samples.
+ Specimens of each species were deposited at the Herbario Nacional, UNAM (MEXU).

SITE 4. This area is located in a High Evergreen Selva similar to SITE 2, but with a lower inclination of only 8 to 10°; it is almost free of rocks at an altitude of 131 meters above sea level. Records of soil and air temperature and humidity are tabulated in FIGURES 5 and 6. The species collected are listed in FIGURE 7.

Site of the germination house. The experiments were carried on in an area that simulated an open soil free of plants and not covered by shade from any plant. The area was near the laboratories of the station in order to be maintained and looked after properly. A few soil samples were brought to Mexico City to be germinated in the greenhouses of the Botanic Garden for comparison and indication of possible differences, but since in all cases there were none, we proceeded with only the analysis of data from our local germination house. Readings of air and soil temperature and humidity in the house are recorded in FIGURES 5 and 6.

Germination of the seeds. Germination was abundant and started almost immediately (after a few days). There were a few seedlings observed that did not continue normal growth; in some cases these were transplanted and care was taken to look for microenvironments. In some cases we were fortunate that these plants continued to grow, in other cases, however, they died. This problem will be discussed later as a possibility for future studies.

More than 80 percent of the species are now identified, (FIGURE 8), leaving only a few still to be determined.

The following species were identified in living condition in the soils of the sampling sites:

QUADRAT 1

Phytolacca decandra L.
Bidens pilosa L.
Iresine celosia L.
Euphorbia heterophylla L.
Neurolaena lobata (L.) R. Br.
Eupatorium sp.

Ageratum conyzoides L.
Clibadium arboreum Donn. Sm.
Clibadium grandifolium Blake
Paspalum sp.
Dioscorea sp.
Solanum torvum Sw.
Verbesina greenmani Urb.
Urera caracasana (Jacq.) Griseb.
Amaranthus hybridus L.
Spigelia palmeri Rose
Heliocarpus aff. *donnell-smithii* Rose
Emilia sonchifolia (L.) DC.
Schistocarpha oppositifolia (Kuntze) Rydb.

QUADRAT 2

Solanum cervantesii Lag.
Lasiacis papillosa Swallen
Phytolacca decandra L.
Cecropia obtusifolia Bert.
Heliocarpus aff. *donnell-smithii* Rose
Bignoniaceae (unidentified)
Turpinia occidentalis (Sw.) G. Don
Sapium lateriflorum Hemsl.
Iresine celosia L.
Belotia campbellii Sprague
Erechtites hieracifolia (L.) Raf.
Pothomorphe umbellata (L.) Miq.
Eupatorium macrophyllum L.
Neurolaena lobata (L.) R. Br.
Ageratum conyzoides L.
Clibadium arboreum Donn. Sm.
Paspalum sp.
Sida acuta Burm.
Trema micrantha (L.) Blume
Robinsonella mirandae Gómez-Pompa
Panicum trichoides Sw.
Bidens pilosa L.
Enterolobium cyclocarpum (Jacq.) Griseb.
Axonopus compressus (Sw.) Beauv.
Amaranthus hybridus L.
Pleuranthodendron mexicana (Gray) L. Wms.

QUADRAT 3

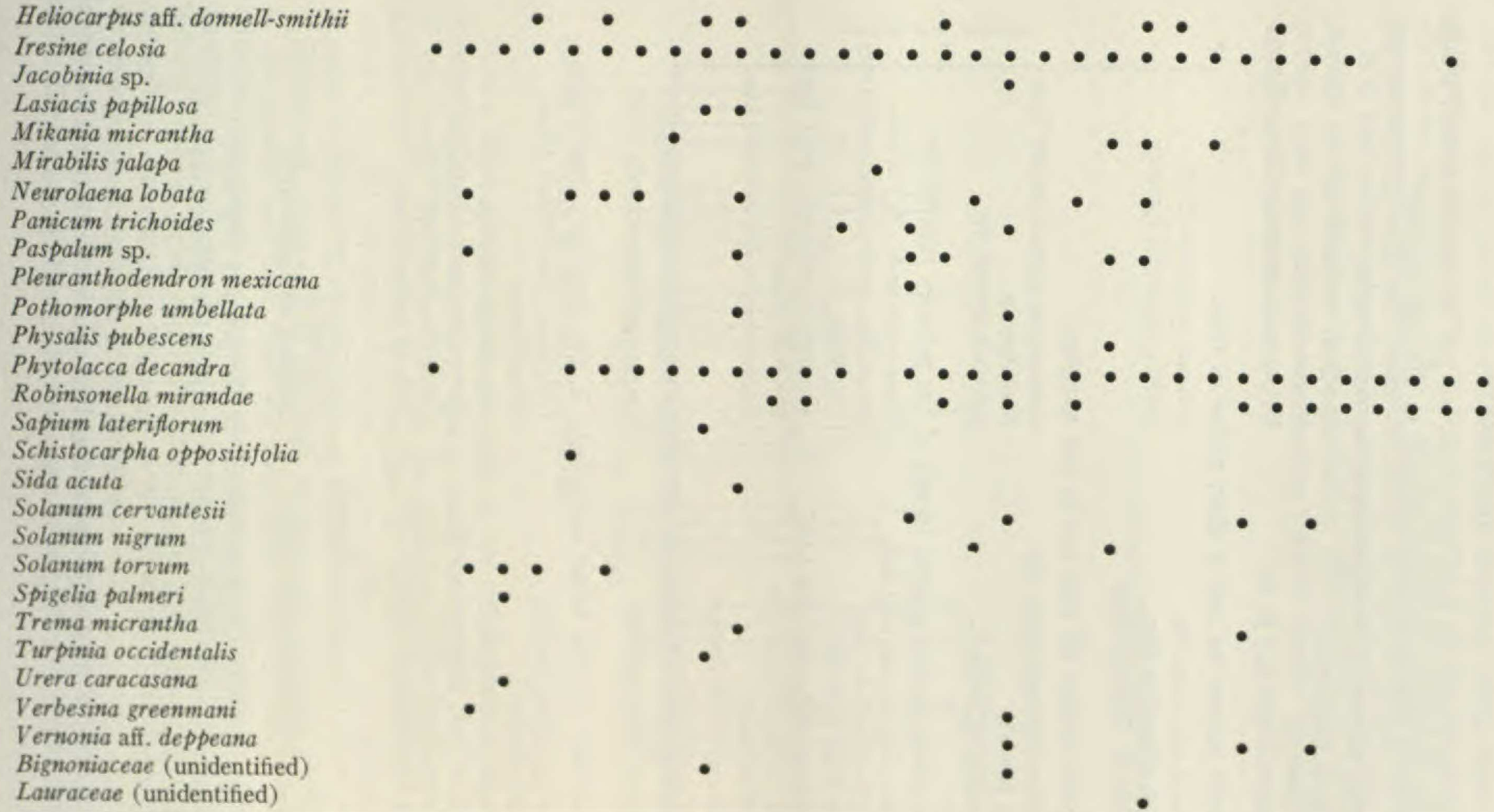
Solanum nigrum L.
Phytolacca decandra L.
Neurolaena lobata (L.) R. Br.
Heliocarpus appendiculatus Turcz.
Bidens pilosa L.
Iresine celosia L.
Pothomorphe umbellata (L.) Miq.
Eupatorium macrophyllum L.
Eupatorium aff. *pansamalense* Rob.
Bignoniaceae (unidentified)
Panicum trichoides Sw.
Vernonia aff. *deppeana* Less.
Solanum cervantesii Lag.
Robinsonella mirandae Gómez-Pompa
Verbesina greenmani Urb.
Eupatorium sp.
Ageratum conyzoides L.
Physalis pubescens L.
Paspalum sp.
Mikania micrantha HBK.
Brosimum alicastrum Sw.
Heliocarpus donnell-smithii Rose
Lauraceae (unidentified)

QUADRAT 4

Phytolacca decandra L.
Croton draco Schlecht.
Vernonia aff. *deppeana* Less.
Iresine celosia L.
Solanum cervantesii Lag.
Robinsonella mirandae Gómez-Pompa
Trema micrantha (L.) Blume
Cecropia obtusifolia Bert.
Heliocarpus donnell-smithii Rose
Eupatorium sp.
Costus spicatus (Jacq.) Sw.
Ageratum conyzoides L.
Desmodium adscendens (Sw.) DC.

FIGURE 8. Species found in the soil samples

SPECIES *	SITE I								SITE II								SITE III								SITE IV							
	Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18
Acalypha schiedeana																			•		•											
Ageratum conyzoides		•		•	•		•			•		•			•					•								•			•	
Amaranthus hybridus			•				•							•	•								•									
Axonopus compressus													•																			
Belotia campbellii									•	•																						
Bidens pilosa	•	•											•				•				•											
Brosimum alicastrum																						•	•	•								
Cecropia obtusifolia									•	•																•						
Cirsium mexicanum			•																		•											
Clibadium arboreum		•	•	•		•		•																								
Clibadium grandifolium		•																														
Costus spicatus																													•			
Croton draco																																
Desmodium adscendens																															•	
Dioscorea sp.		•																														
Emilia sonchifolia				•																												
Enterolobium cyclocarpum													•																	•		
Erechtites hieracifolia																																
Eupatorium sp.		•	•	•	•	•								•	•						•	•	•	•					•		•	
Eupatorium macrophyllum																																
Eupatorium pansamalense																																
Eupatorium pycnocephalum													•																			
Euphorbia heterophylla		•																														
Heliocarpus appendiculatus																																



* Specimens of each species were deposited at the Herbario Nacional, UNAM (MEXU).

DISCUSSION

From the results we have up to now, we can distinguish several groups of species in relation to their presence in the soils sampled:

Species present in the soil all year in most samples:

Phytolacca decandra L.
Eupatorium sp.
Neurolaena lobata (L.) R. Br.
Ageratum conyzoides L.
Iresine celosia L.
Robinsonella mirandae Gómez-Pompa

Species present for only a short period of time:

Brosimum alicastrum Sw.
Cecropia obtusifolia Bert.
Vernonia aff. *deppeana* Less.
Mikania micrantha HBK.
Belotia campbellii Sprague

Species present all year but in few samples:

Clibadium arboreum Donn. Sm.
Bidens pilosa L.
Amaranthus hybridus L.
Heliocarpus donnell-smithii Rose
Paspalum sp.
Solanum torvum Sw.

Secondary species present in soil of the primary rain forest:

Erechtites hieracifolia (L.) Raf.
Cecropia obtusifolia Bert.
Croton draco Schlecht.
Desmodium adscendens (Sw.) DC.
Costus spicatus (Jacq.) Sw.
Sida acuta Burm.
Belotia campbellii Sprague
Trema micrantha (L.) Blume
Pleuranthodendron mexicana (Gray) L. Wms.
Axonopus compressus (Sw.) Beauv.
Mirabilis jalapa L.
Eupatorium pycnocephalum Less.

Primary species present in soil of the secondary vegetation:

Brosimum alicastrum Sw.
Lauraceae (unidentified)

Secondary species found exclusively in the secondary vegetation:

Lasiacis papillosa Swallen
Solanum nigrum L.
Euphorbia heterophylla L.
Eupatorium aff. *pansamalense* Rob.
Physalis pubescens L.
Emilia sonchifolia (L.) DC.
Paspalum sp.
Schistocarpha oppositifolia (Kuntze) Rydb.
Heliocarpus appendiculatus Turcz.
Clibadium grandifolium Blake
Dioscorea sp.
Solanum torvum Sw.
Urera caracasana (Jacq.) Griseb.
Verbesina greenmani Urb.
Spigelia palmeri Rose
Cirsium mexicanum DC.
Acalypha schiedeana Schlecht.
Jacobinia sp.
Mikania micrantha HBK.

Primary species found exclusively in the primary vegetation:

Turpinia occidentalis (Sw.) G. Don
Enterolobium cyclocarpum (Jacq.) Griseb.
Sapium lateriflorum Hemsl.

It is obvious from all the preceding lists that by far the most important floristic element in the soil is composed of secondary species, which are

also the species having longer periods of dormancy (Pijl, 1969). This means that a primary forest can not be restored if all the trees from adjacent areas are destroyed. This is another extremely important argument for conserving large and numerous pieces of tropical selvas.

It is also evident that floristic potential in the soil is a very important element in the direction of the succession. The time of year is also important from this point of view because different species are available in the soil at different seasons.

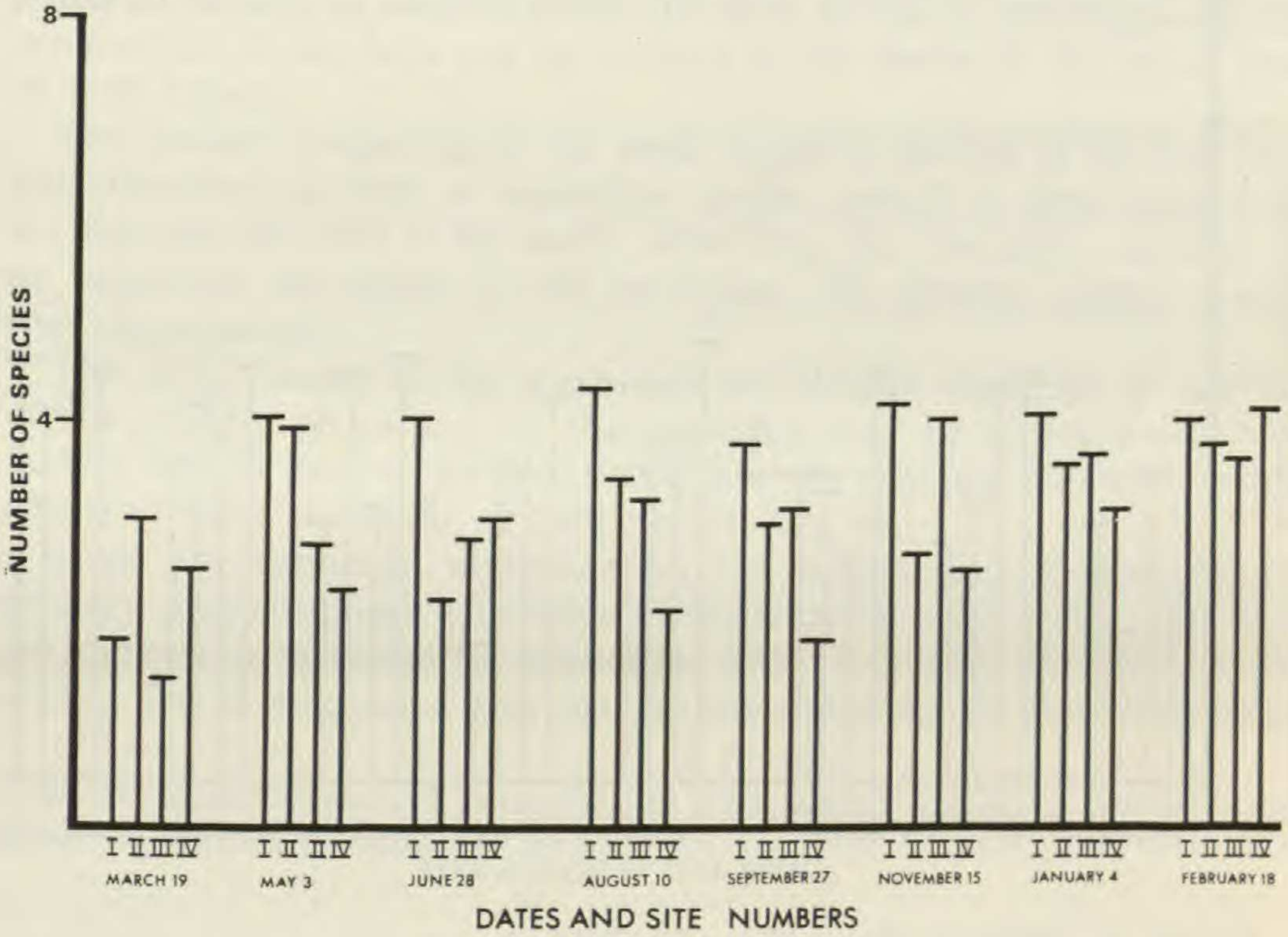


FIGURE 9. Mean of the number of species.

It is a striking fact that in the soils of the primary selvas there is a floristic potential of secondary species ready to function after clearance of the forest. The factor keeping the secondary seeds dormant is unknown and worth investigating, because the species represented are not found in the primary forest. Also the trigger mechanisms should be studied in order to clarify the factors involved in the succession.

We are well aware that in this work we have only scratched the surface of the problem and that there are many other ways to trigger the germination of soil seeds which under the method used (temperature variation, humidity, light, chemicals, etc.) have not germinated or germinated but did not continue growing, probably because the right combination of conditions was not attained. We hope in the future to obtain new data to increase our understanding of this problem.

One of the most interesting fields yet to be explored is that of seed and fruit dispersal (Smythe, 1970) because it is perfectly clear that the

floristic potential can not be built if the seed has not arrived at a given location.

It is also important to add that there is a great need for floristic studies with a solid ecological approach that can be used to interpret the behavior of different species under different ecological conditions and also to study their evolution in connection with secondary environments (Gómez-Pompa, 1971).

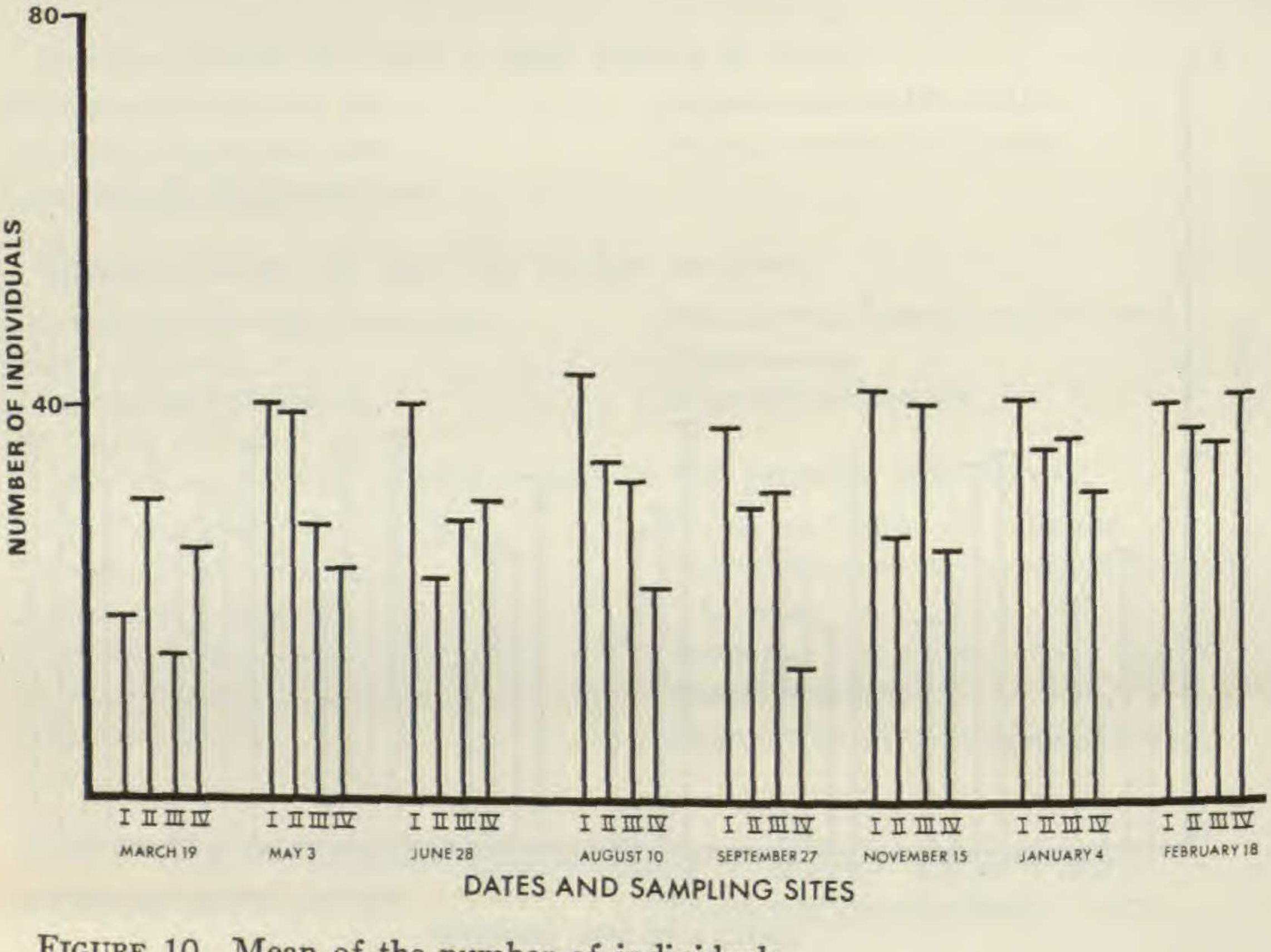


FIGURE 10. Mean of the number of individuals.

The data on the number of species and of individuals per sampling are difficult to evaluate, because there is much variation through time (FIGURES 9, 10, 11, 12). The only interesting observation we can make is that the greatest number of species in our samples occurs in SITE 1; this may be because it is the oldest secondary site, so, time [is] might be responsible for the greater accumulation of secondary species as it might also be for the increase of the number of species in SITE 3. But this interpretation should be confirmed because there is much variation and the number of samples made by us is not enough to give a completely satisfactory interpretation.

The temperature data of the four sites and of the germination house showed some differences (FIGURE 6) between the secondary and the primary sites, being more variable in the secondary locations. It is of interest that there is very little variation in soil temperature throughout the year. Nevertheless the temperature of a naked soil is very different from that of a vegetation-covered one (FIGURE 1), especially in the middle of

the day. We believe that this difference may explain the response of certain dormant seeds to the clearing of the forest. The temperatures in our germinating house were closer to those of a bare soil and the response we obtained from the plants was similar to that of an early colonized open soil.

CONCLUSIONS

The germination method is an effective one for evaluating the floristic potential of soils in tropical areas. In order to use it advantageously the composition of the flora and the ecology of the species of the region must be well known.

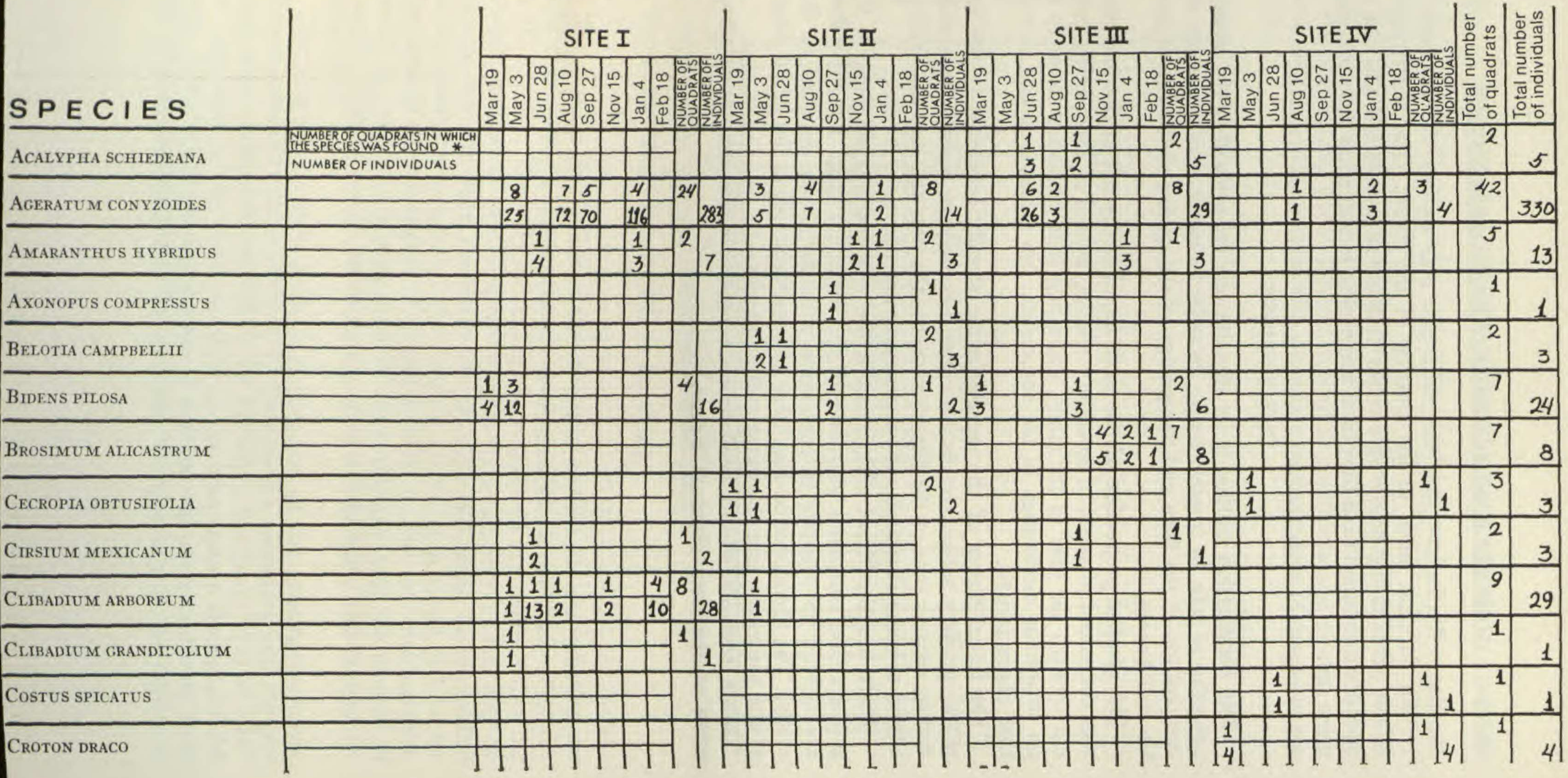
The greatest proportion of the seeds found in the soil of the four sites was comprised of seeds of secondary species, several of them being present through the year of the study, indicating that dormancy seems to be an important mechanism in the succession. No primary species showed that characteristic.

The initial stages of the succession are already imprinted in the soil of the primary selvas and its characteristics may be derived from other factors such as time of the initiation during the year and may also include effects of some chemicals, of temperature, fire, etc.

There are significant differences in the temperatures obtained in the primary sites compared with those of the secondary ones. But these data are difficult to evaluate in connection with the results obtained in this study. The thermoperiod may play an important role in the initial stages of the succession but this must still be proven.

More research should be done on comparable problems to reinforce some of the data obtained by us.

FIGURE 11. Statistical data on the species found in the soil samples



Desmodium adscendens																																			1	1	1
																																			2	2	2
Dioscorea sp.		1							1																												1
		2							2																												2
Emilia sonchifolia					1				1																												1
					1				1																												1
Enterolobium cyclocarpum														1				1											1							1	2
														1				1											1							1	2
Erechtites hieracifolia											1							1																			1
											1							1																			1
Eupatorium sp.		1	10		6	5		8	30					4	3			7			5	2	4	1		3	15			2		4				6	58
		2	60		65	120		160	387					5	6			11			25	3	6	1		30	65			2		14				16	479
Eupatorium macrophyllum											1							1		1			1				2										3
											1							1		5			1				6										7
Eupatorium pansamalense																				1							1										1
																				5							5										5
Eupatorium pycnocephalum														1				1																			1
														2				2																			5
Euphorbia heterophylla		1							1																												1
		1							1																												1
Heliocarpus appendiculatus																			1								1										1
																			1								1										1
Heliocarpus aff. donnell-smithii				1		1			2	5	1						3	9						1	1		2		1							1	14
				1		1			2	10	1						9	20						1	1		2		1							1	25
Iresine celosia	5	12	10	9	1	3	2	6	48	6	11	3	7	2	3	4	3	39	9	12	11	13	4	6	5	10	70	6	6	5	3			4	2	26	183
	8	68	41	42	4	33	20	62	218	7	24	4	8	4	5	8	11	71	40	139	161	172	44	69	26	124	781	7	25	11	3			7	10	63	1193
Jacobinia sp.																				1							1										1
																				2							2										2

FIGURE 11. Statistical data on the species found in the soil samples

SITE I

SPECIES		Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Number of quadrats	Number of individuals
Lasiacis papillosa	Number of quadrats in which the species was found *										
	Number of individuals										
Mikania micrantha									1	1	
									1		1
Mirabilis jalapa											
Neurolaena lobata			1		1	1	1			4	
			1		1	1	1				4
Panicum trichoides											
Paspalum sp.		1								1	
		3									3
Pleuranthodendron mexicana											
Pothomorphe umbellata											
Physalis pubescens											
Phytolacca decandra		6				2	2	7	2	19	
		8				3	5	36	16		68
Robinsonella mirandae											
Sapium lateriflorum											

SITE II

SPECIES		Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Number of quadrats	Number of individuals
Lasiacis papillosa	Number of quadrats in which the species was found *	1	1							2	
	Number of individuals	1	1								2
Mikania micrantha											
Mirabilis jalapa							1			1	
							2				2
Neurolaena lobata			1							1	
			1								1
Panicum trichoides						1		1		2	
						2		1			3
Paspalum sp.		1		1				1	1	4	
		1		1				1	2		5
Pleuranthodendron mexicana								1		1	
								3			3
Pothomorphe umbellata			3							3	
			6								6
Physalis pubescens											
Phytolacca decandra		6	3	1	3	4		8	3	28	
		14	3	1	4	5		28	16		71
Robinsonella mirandae				1	1				5	7	
				1	2				15		18
Sapium lateriflorum		1								1	
		2									2

SITE III

SPECIES		Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Number of quadrats	Number of individuals
Lasiacis papillosa	Number of quadrats in which the species was found *										
	Number of individuals										
Mikania micrantha						1	1		2	4	
						1	1		17		19
Mirabilis jalapa											
Neurolaena lobata		1			1		1			3	
		1			1		1				3
Panicum trichoides			1							1	
			1								1
Paspalum sp.						1	1			2	
						1	2				3
Pleuranthodendron mexicana											
Pothomorphe umbellata			1							1	
			1								1
Physalis pubescens						1				1	
						1					1
Phytolacca decandra		10	1		1	4	1	9	2	28	
		70	1		1	26	1	114	40		253
Robinsonella mirandae			5		2					7	
			5		5						10
Sapium lateriflorum											

SITE IV

SPECIES		Mar 19	May 3	Jun 28	Aug 10	Sep 27	Nov 15	Jan 4	Feb 18	Number of quadrats	Number of individuals
Lasiacis papillosa	Number of quadrats in which the species was found *										
	Number of individuals										
Mikania micrantha											
Mirabilis jalapa											
Neurolaena lobata											
Panicum trichoides											
Paspalum sp.											
Pleuranthodendron mexicana											
Pothomorphe umbellata											
Physalis pubescens											
Phytolacca decandra		6	1	1	1	2	1	3	3	18	
		11	2	1	1	2	1	7	6		31
Robinsonella mirandae		1	7	7	9	2	7	8	9	50	
		2	17	17	19	2	12	15	25		109
Sapium lateriflorum											

TOTALS

SPECIES		Total number of quadrats	Total number of individuals
Lasiacis papillosa	Number of quadrats in which the species was found *	2	
	Number of individuals		2
Mikania micrantha		5	
			20
Mirabilis jalapa		1	
			2
Neurolaena lobata		8	
			8
Panicum trichoides		3	
			4
Paspalum sp.		7	
			11
Pleuranthodendron mexicana		1	
			3
Pothomorphe umbellata		4	
			7
Physalis pubescens		1	
			1
Phytolacca decandra		95	
			423
Robinsonella mirandae		64	
			137
Sapium lateriflorum		1	
			2

Schistocarpha oppositifolia						1				1																															1	
						2					2																																	2
Sida acuta													1							1																						1	
													2								2																								2
Solanum cervantesii																			1		1			1							1		1		1						2		4	
																			1			1		1								1	2		2							4		6
Solanum nigrum																							1				1				2													2	
																							2				1					3												3
Solanum torvum			1	1	1		1			4																															4	
			2	1	2		1				6																																6
Spigelia palmeri				1						1																																	1	
				4							4																																4
Trema micrantha													1							1																1								1		2	
													1								1																1									1		2
Turpinia occidentalis												1								1																								1	
												1									1																									1
Urera caracasana				1						1																																	1	
				1							1																																1
Verbesina greenmani			1							1														1							1													2	
			1								1														1								1												2
Vernonia aff. deppeana																									1							1		1		1						2		3	
																									1								1	1		1							2		3
Bignoniaceae												1								1			1							1													2	
												1									1		1								1												2
Lauraceae																													1			1													1	
																													1				1												1

FIGURE 12. **Seed content per m^2**

SEEDS PER M^2 12 CM. DEPTH	MAR 19	MAY 3	JUN 28	AUG 10	SEP 27	NOV 15	JAN 4	FER 18
SITE I	1982	3879	2937	3275	1982	4051	3189	3706
SITE II	517	862	344	603	431	431	862	862
SITE III	1120	1293	1439	1637	948	862	1560	2672
SITE IV	603	689	431	258	175	344	431	517

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